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Longevity of Blue Lupine Seed

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FACTORS AFFECTING THE LONGEVITY OF BLUE LUPINE SEED[1]

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The blue and the yellow lupines[3] have become important winter annual legumes in the lower southeastern part of the United States, for soil improvement and for grazing. The annual production of lupine seed increased from a few hundred pounds in 1938 to over 50 million pounds in 1947. Since 1947 annual production has varied from year to year but has averaged 66 m billion pounds, all coming from the States of Georgia, Florida, South Carolina, and Alabama.

Back in 1938 only the bitter, high-alkaloid varieties of blue lupine were grown. Since then, varieties low in alkaloid and suitable for feed and forage have been introduced, according to "Lupine Seed Production," Crop Reporting Board, AMS, USDA. By 1957, 83-percent of the total lupine seed crop was of the bitter (high-alkaloid) blue species. The remainder of the lupine seed crop is made up of sweet (low-alkaloid) varieties of the blue and yellow species. These low-alkaloid varieties are used either for winter grazing or for soil improvement. In the lower South lupines are sown during the fall months and are harvested for seed in May or early June.

The pods of maturing blue lupine seed open abruptly and release the seed. This makes for high losses if harvesting is delayed, particularly if hot, dry weather prevails at maturity. To avoid excessive seed losses, growers should begin harvesting operations while the seed contains 16 to 20 percent or more moisture. Producers and distributors have experienced difficulty in handling and storing lupine seed so as to retain its viability. The situation became so serious that in 1947 studies were initiated to determine the factor or factors responsible for lowered viability and to develop remedial measures.

Seed maturity, combine adjustments in harvesting, cleaning, drying, and temperature and humidity conditions in storage are important factors that must be considered to obtain high-quality seed.

SEED MATURITY

Because of its shattering characteristic, blue lupine seed must be harvested before it becomes dry enough for safe storage. Often the plants in the field ripen unevenly, because of soil variability. To get maximum yields it is necessary to harvest the crop when some plants are comparatively immature. Seed from these less mature plants are one-third to one-half times larger than the drier seed and green in color. It is important to know, first, if such large green seed from such plants are potentially good seed, and second, if it is profitable to save such seed. Studies were conducted on the value of such seed for planting purposes when properly dried.

The studies revealed that the large green seed may contain as much as 57-percent moisture, requiring a longer period of drying than the more mature seed. Approximately 25 percent of the green seed burst open in the normal course of drying and many were off-color and shriveled. The dried green seed germinated only 50-percent after a month of storage.

Since the green seed required a longer drying period and were of poor quality, it was concluded that they should be screened from each seed lot before drying.

MECHANICAL INJURY IN HARVESTING

Practically all forms of injury described for other legume seed have been found in lupines. Perhaps the most frequently observed type of injury in lupine seed is that in which one or both of the cotyledons are broken from the hypocotyl. Varying degrees of hypocotyl injury, frequently resulting in abnormal growth, are common. It is not the purpose of this publication to discuss mechanical injury in detail, but rather to point out that it does occur and to discuss briefly how it can happen.

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[1] Cooperative investigations of the Georgia Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U. S. D. A.

[2] Physiologist, pathologist (retired), and research agronomist, respectively, of the Crops Research Division, Agricultural Research Service, U. S. D. A. Burns is located at Experiment, Ga., and Henson at Beltsville, Md.

[3] Lupinus angustifolius and L. luteus, respectively.

Combine Injury[4]

The effect of cylinder speed (angle bar type) and concave clearances in combining blue lupine seed of different moisture contents were studied in comparison with hand-harvested and cleaned seed. While the tests were not as extensive as might be desired, the importance of seed moisture content was clearly indicated. Germination was reduced 15-percent in seed containing only 15-percent moisture when combined at a cylinder speed of 900 rpm. with the cylinder concave spacing set at 5/8-inch. Severe damage occurred at higher cylinder speeds. Seed containing 24-percent moisture germinated 94-percent when combined at a cylinder speed of 900 rpm. with the 5/8-inch cylinder concave spacing. These results indicate that the lowest cylinder speed with the widest cylinder concave spacing that will thresh the pods is most suitable for lupines. The drier the seed the more important are proper settings.

Processing Damage

In the process of cleaning and drying seed it may be elevated to the highest point in the building and allowed to drop at high speeds through metal pipes into bins and bagging equipment. It is possible that the seed will be injured in this process.

Seed of different moisture contents were dropped from various heights up to 11 feet onto substances of different degrees of hardness. Some injury and a 10-percent reduction in germination resulted when seed containing less than 12-percent moisture were dropped from a height of 10 or 11 feet on a concrete floor. Little or no damage occurred with seed containing higher moisture contents. Dry seed striking each other at a relatively high velocity can be injured if they strike at such an angle that the hypocotyl or radicle is broken or otherwise damaged.

The results of these tests show that high-moisture seed are less easily injured than dry seed. Processing plants should be so constructed that at no time will the seed fall long distances through rough pipe, especially after it has been dried.

EFFECT OF MECHANICAL INJURY ON LONGEVITY

It is important to know if mechanically injured seed will retain its viability in storage. The longevity of stored seed lots containing damaged seed has been compared with the longevity of stored undamaged seed lots. Under reasonably good storage conditions differences in losses of viability have not been apparent. Under more adverse storage conditions, particularly where very high humidity prevails, the lots containing damaged seed did deteriorate more rapidly in storage. These studies indicate that seed lots containing appreciable quantities of damaged seed should be planted the first planting season, not held over into the second year.

HEATING OF LUPINE SEED

Heating has not been a serious problem in freshly combined, uniformly dry lupine seed harvested during good drying weather. Lupine seed will be high in percent moisture when harvested during extended periods of wet, humid weather and will contain green trash and pods. These green segments of plant tissue have a high moisture content and tend to increase considerably the relative humidity of the air in a bag or bulk lot of seed. Free water may accumulate on seeds adjacent to very moist trash. Immediately after harvest of such seed lots, rapid heating accompanied by a loss of viability may occur in a matter of a few hours.

In some instances bags of freshly combined high-moisture seed containing considerable quantities of green trash are permitted to lie on the ground singly or in piles several hours before they are trucked to the drier. Even after loading several bags deep, the seed may stand for several hours, frequently in the hot sun before it is processed. Studies have shown that during the period between combining and drying, the temperature of such seed may rise considerably owing to the combination of heat from the sun and that from the high respiration of moist trash, as well as from the activity of bacteria and fungi growing on the surfaces of the wet plant material and seed.

Experiments designed to produce heating were not always successful. Where heating occurred, seed and trash were excessively high in moisture. The presence of bacteria could be detected by the slimy feel of the seed within 24 hours; and of molds soon thereafter. These microorganisms played a major role in the generation of heat.

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[4] Studied in cooperation with the Agricultural Engineering Department, Georgia Agricultural Experiment Station, Experiment, Ga.

Seed combined in an extended period of wet, humid weather should be hauled immediately to the drier as it comes from the combine. Four to 6 hours of delay can seriously reduce the viability of the seed.

DRYING LUPINE SEED

Since blue lupine is usually harvested too moist for safe storage, some means of artificial drying is necessary. For the small grower who harvests a few hundred pounds of seed it may be possible to dry the seed by spreading it in a thin layer on a suitable floor. For the producer of larger quantities, drying with heated or forced air is necessary.

Studies were conducted on the effect of heated air on seed viability. Seed containing 24-percent moisture or less were dried with heated air at carefully controlled temperatures from 110° to 135° F. These seeds were germinated and the sprouts measured. No difference in percentage of germination or in length of sprouts was found between seed dried at temperatures up to 135° F. and seed dried with unheated air. In drying seed with a higher moisture content than 24-percent, there was definite injury at 135° F., but at 130° there was only a slight evidence of possible injury.

Since high-moisture seed is more sensitive to heat than drier seed, a study was made to determine the air temperature at various depths in a bin drier in which incoming air was 130° F. Seed with 22-percent moisture was placed in a small laboratory drier and the temperature measured at various distances from the bottom (figure 1) by means of thermocouples. Airflow through the drier was excessive. It can be seen from the figure that considerable time elapses before seed some distance from the bottom of the bin reaches the temperature of the incoming air. Very few seeds in a bin drier would be exposed to the temperature of the incoming air before they have dried to some extent.

From these studies over a period of 3 years it would appear that lupine seed with a moisture content of 18-percent or less can be dried at 125° F. with a liberal safety margin. However, some seed lots may run slightly higher than 18-percent moisture, therefore the lower temperatures of 110° to 120° F. are recommended.

SEED-MOISTURE-CONTENT AND TEMPERATURE EFFECTS ON LONGEVITY IN STORAGE

A number of laboratory studies were conducted to determine specific effects at different temperatures and seed-moisture contents on the viability of lupine seed in storage.

Seed containing 14.5-percent moisture began to decline in viability after 3 months in storage at 86° F., but losses in germination were delayed 6 months or more at 77° or 68° F. At higher seed moistures, losses in germination were more rapid. These data indicate that seed should be dried to 12-percent moisture for safekeeping in usual storage facilities.

Seed of different moisture content was stored in commercial seed houses at Ashford, Ala., and Experiment, Vienna, and Thomasville, Ga. The results of this test have shown that seed placed in storage with a moisture content over 15-percent deteriorated more rapidly than that placed in storage at lower moisture content.

There was no relationship between the moisture at which seed was placed in storage and the moisture attained by the seed after 3 or more months in storage. Seed quickly reaches a moisture-content equilibrium with the relative humidity of the surrounding air and varies somewhat as the relative humidity varies. At the two locations, Thomasville and Experiment, Ga., the moisture content of the seed was over 12.5-percent at most samplings; at the other locations it was usually lower.

Insulation quality of warehouse construction apparently has little effect on seed quality. The Ashford, Ala., warehouse was a well-ventilated sheet-metal building with the seed stored near an outside corner. At Vienna, Ga., the seed was in a tight, hollow-tile warehouse with the seed located along an inside wall. Both the Thomasville and Experiment structures were smaller, the one at Thomasville being frame and that at Experiment poured concrete.

Lupine seed containing 12-percent moisture or less has kept equally well in burlap bags or in bulk.

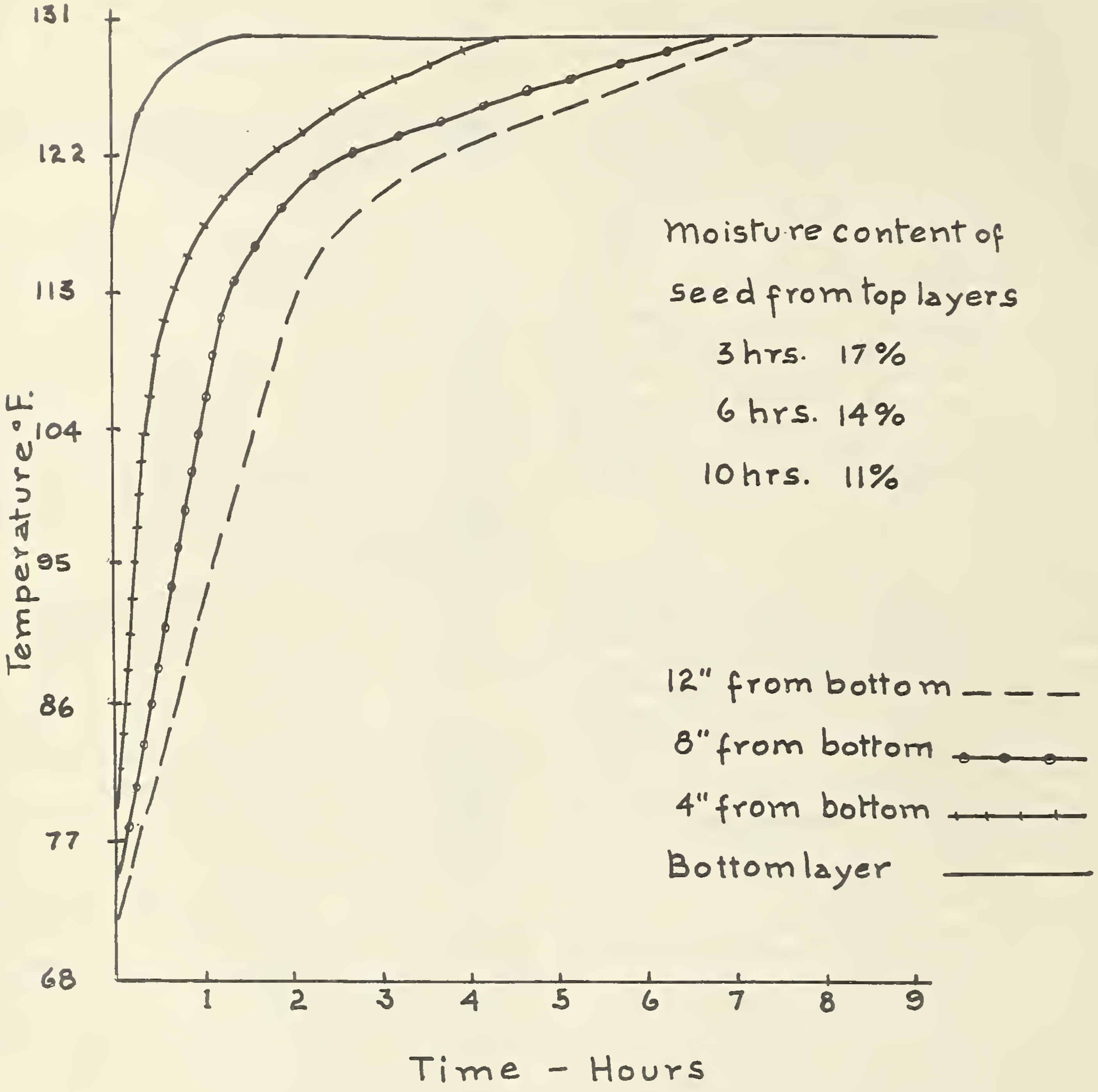

Figure 1.--The temperature curve at various levels in 22-percent-moisture lupine seed being dried with air heated to 130° F.

Bin Storage

When the relative humidity of the atmosphere is low, seed with too high moisture content for safe storage can be dried to a safe level and maintained at that level by using bins with floors perforated for forcing air through the seed. Air can be forced through the seed in these bins by a blower which is controlled by a humidistat operating the blower when the relative humidity falls to 50-percent or less. Seed 6 inches or more below the surface are lower in percent moisture than the top layer of seed. The seed in such bins maintained a moisture of less than 10-percent for more than 4 years. Deterioration has been negligible in the seed 6 inches and more below the surface. In seed with a moisture content of 13-percent stored in a similar but unventilated bin, germination dropped 10-percent or more.

SUMMARY

Studies have been conducted to determine the factors responsible for lowered viability of blue lupine seed in storage.

Cylinder speed and concave setting are important in combining lupine seed. Too high cylinder speeds or too close cylinder concave settings caused very severe damage in combining dry lupine seed. Higher moisture seed were less readily injured. Limited tests indicate that less damage resulted when the cylinder speed was cut down to the lowest speed consistent with efficient work. The exact cylinder speed varies with the maturity and moisture content of the plant and seed.

Blue lupine seed having a high moisture content and containing appreciable quantities of green trash, usually true of freshly combined seed, are likely to heat if not properly handled. The danger from heating was greatly reduced when seed was cleaned immediately after combining.

Seed lots of various moisture contents stored over a period of time in commercial storage have not deteriorated in 2 years where seed moistures have been under 13.5-percent. Where longer storage is desired seed should be dried to 12-percent moisture or lower.

While high drying temperatures may reduce germination of lupine seed, especially if it has a high moisture content, drying temperatures of 110° to 120° F. allow an ample safety margin.

Blue lupine seed was also damaged by rough handling, such as might occur in drying or processing the seed. Dry seed allowed to fall 10 or 11 feet onto a hard surface was damaged. There was also some evidence that damaged seed lost their viability more rapidly than undamaged seed in storage.

In combining blue lupine seed in the lower South, various amounts of large green seed, 30 to 50-percent larger than the drier seed, are usually present in freshly harvested seed. Such seed are injured in combining, which results in seedcoats splitting during drying. Before a lot of seed is dried, the large green seed should be screened out and discarded.